C. Claims

The following is a complete listing of the claims, and replaces all earlier versions and listings.

1. (Original) A method for manufacturing a minute structure, comprising:

a step of forming an ionizing radiation decomposing type positive type resist layer including a methyl isopropenyl ketone as a first positive type photosensitive material layer to be sensitized by an ionizing radiation of a first wavelength range;

a step of forming an ionizing radiation decomposing type positive type resist layer including a photosensitive material of a copolymer obtained by the copolymerization of an ester methacrylate and a methacrylic acid, with the weight average molecular weight of the copolymer of 50,000 to 300,000 and the ratio of the methacrylic acid included in the copolymer of 5 to 30% by weight as a second positive type photosensitive material layer to be sensitized by an ionizing radiation of a second wavelength range on the first positive type photosensitive material layer;

a step of forming a desired pattern in the above-mentioned second positive type photosensitive material layer as the upper layer by decomposing reaction only in the desired area of the above-mentioned second positive type photosensitive material layer without decomposing reaction of the above-mentioned first positive type photosensitive material layer by directing an ionizing radiation of the above-mentioned second wavelength range via a mask to the substrate surface with the first and second positive type

photosensitive material layers formed, and development using a developing solution, and then;

a step of forming a desired pattern in the above-mentioned first positive type photosensitive material layer as the lower layer by decomposing reaction of a predetermined area of at least the above-mentioned first positive type photosensitive material layer by direction an ionizing radiation of the above-mentioned first wavelength range via a mask to the substrate surface with the first and second positive type photosensitive material layers formed, and development, successively;

characterized in that a pattern of a convex shape is manufactured in the substrate by executing the above-mentioned steps.

2. (Original) A method for manufacturing a minute structure, comprising:

a step of forming an ionizing radiation decomposing type positive type resist layer including a methyl isopropenyl ketone as a first positive type photosensitive material layer to be sensitized by an ionizing radiation of a first wavelength range;

a step of forming an ionizing radiation decomposing type positive type resist layer including a photosensitive material of a copolymer obtained by the copolymerization of an ester methacrylate and a methacrylic anhydride, with the weight average molecular weight of the copolymer of 10,000 to 100,000 and the ratio of the methacrylic anhydride included in the copolymer of 5 to 30% by weight as a second positive type photosensitive

material layer to be sensitized by an ionizing radiation of a second wavelength range on the first positive type photosensitive material layer;

a step of forming a desired pattern in the above-mentioned second positive type photosensitive material layer as the upper layer by decomposing reaction only in the desired area of the above-mentioned second positive type photosensitive material layer without decomposing reaction of the above-mentioned first positive type photosensitive material layer by directing an ionizing radiation of the above-mentioned second wavelength range via a mask to the substrate surface with the first and second positive type photosensitive material layers formed, and development using a developing solution, and then;

a step of forming a desired pattern in the above-mentioned first positive type photosensitive material layer as the lower layer by decomposing reaction of a predetermined area of at least the above-mentioned first positive type photosensitive material layer by direction an ionizing radiation of the above-mentioned first wavelength range via a mask to the substrate surface with the first and second positive type photosensitive material layers formed, and development, successively;

characterized in that a pattern of a convex shape is manufactured in the substrate by executing the above-mentioned steps.

3. (Currently Amended) The method for manufacturing a minute structure according to claim 1 [[or 2]], wherein the first positive type photosensitive material layer is obtained by forming a first positive type photosensitive material layer by a

solvent coating method, vaporizing the coating solvent in the layer by heating, coating a material for forming the second positive type photosensitive material layer, and vaporizing the coating solvent by applying the heat to the formed coating layer.

4. (Original) A method for manufacturing a liquid discharge head comprising a step of forming a mold pattern with a removable resin in a liquid flow path forming portion on a substrate with a liquid discharge energy generating element formed, applying and hardening a coating resin layer on the above-mentioned substrate so as to coat the mold pattern, and dissolving and removing the above-mentioned mold pattern so as to form a liquid flow pat, characterized in that the above-mentioned step of forming a mold pattern comprises:

a step of forming an ionizing radiation decomposing type positive type resist layer including a methyl isopropenyl ketone as the first positive type photosensitive material layer to be sensitized by an ionizing radiation beam of the first wavelength range on the substrate;

a step of forming an ionizing radiation decomposing type positive type resist layer including a photosensitive material of a copolymer obtained by the copolymerization of an ester methacrylate and a methacrylic acid, with the weight average molecular weight of the copolymer of 50,000 to 300,000 and the ratio of the methacrylic acid included in the copolymer of 5 to 30% by weight as a second positive type photosensitive material layer to be sensitized by an ionizing radiation of a second wavelength range on the first positive type photosensitive material layer;

a step of forming a desired pattern in the above-mentioned second positive type photosensitive material layer as the upper layer by decomposing reaction only in the desired area of the above-mentioned second positive type photosensitive material layer without decomposing reaction of the above-mentioned first positive type photosensitive material layer by directing an ionizing radiation of the above-mentioned second wavelength range via a mask to the substrate surface with the first and second positive type photosensitive material layers formed, and development using a developing solution; and

a step of forming a desired pattern in the above-mentioned first positive type photosensitive material layer as the lower layer by decomposing reaction of a predetermined area of at least the above-mentioned first positive type photosensitive material layer by direction an ionizing radiation of the above-mentioned first wavelength range via a mask to the substrate surface with the first and second positive type photosensitive material layers formed, and development, successively.

5. (Original) A method for manufacturing a liquid discharge head comprising a step of forming a mold pattern with a removable resin in a liquid flow path forming portion on a substrate with a liquid discharge energy generating element formed, applying and hardening a coating resin layer on the above-mentioned substrate so as to coat the mold pattern, and dissolving and removing the above-mentioned mold pattern so as to form a liquid flow pat, characterized in that the above-mentioned step of forming a mold pattern comprises:

a step of forming an ionizing radiation decomposing type positive type resist layer including a methyl isopropenyl ketone as the first positive type photosensitive material layer to be sensitized by an ionizing radiation beam of the first wavelength range on the substrate;

a step of forming an ionizing radiation decomposing type positive type resist layer including a photosensitive material of a copolymer obtained by the copolymerization of an ester methacrylate and a methacrylic anhydride, with the weight average molecular weight of the copolymer of 10,000 to 100,000 and the ratio of the methacrylic anhydride included in the copolymer of 5 to 30% by weight as a second positive type photosensitive material layer to be sensitized by an ionizing radiation of a second wavelength range on the first positive type photosensitive material layer;

a step of forming a desired pattern in the above-mentioned second positive type photosensitive material layer as the upper layer by decomposing reaction only in the desired area of the above-mentioned second positive type photosensitive material layer without decomposing reaction of the above-mentioned first positive type photosensitive material layer by directing an ionizing radiation of the above-mentioned second wavelength range via a mask to the substrate surface with the first and second positive type photosensitive material layers formed, and development using a developing solution; and

a step of forming a desired pattern in the above-mentioned first positive type photosensitive material layer as the lower layer by decomposing reaction of a predetermined area of at least the above-mentioned first positive type photosensitive material layer by direction an ionizing radiation of the above-mentioned first wavelength

range via a mask to the substrate surface with the first and second positive type photosensitive material layers formed, and development, successively.

6. (Original) A method for manufacturing a liquid discharge head comprising a step of forming a mold pattern with a removable resin in a liquid flow path forming portion on a substrate with a liquid discharge energy generating element formed, applying and hardening a coating resin layer on the above-mentioned substrate so as to coat the mold pattern, and dissolving and removing the above-mentioned mold pattern so as to form a liquid flow pat, characterized in comprising at least:

a step of forming an ionizing radiation decomposing type positive type resist layer including a methyl isopropenyl ketone as the first positive type photosensitive material layer to be sensitized by an ionizing radiation beam of the first wavelength range on the substrate;

a step of forming an ionizing radiation decomposing type positive type resist layer including a photosensitive material of a copolymer obtained by the copolymerization of an ester methacrylate and a methacrylic acid, with the weight average molecular weight of the copolymer of 50,000 to 300,000 and the ratio of the methacrylic acid included in the copolymer of 5 to 30% by weight as a second positive type photosensitive material layer to be sensitized by an ionizing radiation of a second wavelength range on the first positive type photosensitive material layer;

a step of forming a desired pattern in the above-mentioned second positive type photosensitive material layer as the upper layer by decomposing reaction only in the

desired area of the above-mentioned second positive type photosensitive material layer without decomposing reaction of the above-mentioned first positive type photosensitive material layer by directing an ionizing radiation of the above-mentioned second wavelength range via a mask to the substrate surface with the first and second positive type photosensitive material layers formed, and development using a developing solution,

a step of forming a desired pattern in the above-mentioned first positive type photosensitive material layer as the lower layer by decomposing reaction of a predetermined area of at least the above-mentioned first positive type photosensitive material layer by direction an ionizing radiation of the above-mentioned first wavelength range via a mask to the substrate surface with the first and second positive type photosensitive material layers formed, and development;

a step of forming a pattern including the discharge port by applying a photosensitive coating resin film onto the first and second positive type photosensitive material layers with the above-mentioned desired pattern formed, exposing a pattern including a discharge opening communicating with the above-mentioned liquid flow path, and development;

a step of decomposing the resin components in the pattern comprising the above-mentioned first and second positive type photosensitive material layers by directing an ionizing radiation beam of a wavelength range for the decomposing reaction of both the above-mentioned first and second positive type photosensitive material layers via the above-mentioned photosensitive coating resin film; and

a step of soaking the substrate after having the above-mentioned steps in a predetermined organic solvent for dissolving and removing the pattern comprising the above-mentioned first and second positive type photosensitive material layers.

7. (Original) A method for manufacturing a liquid discharge head comprising a step of forming a mold pattern with a removable resin in a liquid flow path forming portion on a substrate with a liquid discharge energy generating element formed, applying and hardening a coating resin layer on the above-mentioned substrate so as to coat the mold pattern, and dissolving and removing the above-mentioned mold pattern so as to form a liquid flow pat, characterized in comprising at least:

a step of forming an ionizing radiation decomposing type positive type resist layer including a methyl isopropenyl ketone as the first positive type photosensitive material layer to be sensitized by an ionizing radiation beam of the first wavelength range on the substrate;

a step of forming an ionizing radiation decomposing type positive type resist layer including a photosensitive material of a copolymer obtained by the copolymerization of an ester methacrylate and a methacrylic anhydride, with the weight average molecular weight of the copolymer of 10,000 to 100,000 and the ratio of the methacrylic anhydride included in the copolymer of 5 to 30% by weight as a second positive type photosensitive material layer to be sensitized by an ionizing radiation of a second wavelength range on the first positive type photosensitive material layer;

a step of forming a desired pattern in the above-mentioned second positive type photosensitive material layer as the upper layer by decomposing reaction only in the desired area of the above-mentioned second positive type photosensitive material layer without decomposing reaction of the above-mentioned first positive type photosensitive material layer by directing an ionizing radiation of the above-mentioned second wavelength range via a mask to the substrate surface with the first and second positive type photosensitive material layers formed, and development using a developing solution;

a step of forming a desired pattern in the above-mentioned first positive type photosensitive material layer as the lower layer by decomposing reaction of a predetermined area of at least the above-mentioned first positive type photosensitive material layer by direction an ionizing radiation of the above-mentioned first wavelength range via a mask to the substrate surface with the first and second positive type photosensitive material layers formed, and development;

a step of forming a pattern including the discharge port by applying a photosensitive coating resin film onto the first and second positive type photosensitive material layers with the above-mentioned desired pattern formed, exposing a pattern including a discharge opening communicating with the above-mentioned liquid flow path, and development;

a step of decomposing the resin components in the pattern comprising the above-mentioned first and second positive type photosensitive material layers by directing an ionizing radiation beam of a wavelength range for the decomposing reaction of both the

above-mentioned first and second positive type photosensitive material layers via the above-mentioned photosensitive coating resin film; and

a step of soaking the substrate after having the above-mentioned steps in a predetermined organic solvent for dissolving and removing the pattern comprising the above-mentioned first and second positive type photosensitive material layers.

8. (Currently Amended) The method for manufacturing a liquid discharge head according to ~~any of claims 4 to 7~~ claim 4, wherein the first positive type photosensitive material layer is obtained by forming a first positive type photosensitive material layer by a solvent coating method, vaporizing the coating solvent in the layer by heating, coating a material for forming the second positive type photosensitive material layer, and vaporizing the coating solvent by applying the heat to the formed coating layer.

9. (Currently Amended) The method for manufacturing a liquid discharge head according to ~~any of claims 4 to 7~~ claim 4, wherein the first wavelength range for sensitizing the first positive type photosensitive material layer is a 270 nm to 350 nm range, and the second wavelength range for sensitizing the second positive type photosensitive material layer is a 230 nm to 260 nm range.

10. (Currently Amended) A liquid discharge head manufactured by the method for manufacturing a liquid discharge head according to ~~any of claims 4 to 9~~ claim

4, wherein the height of the liquid flow path is provided relatively lower at a point adjacent to the bubble generating chamber on the liquid discharge energy generating element.

11. (Original) The liquid discharge head according to claim 10, wherein the cross-sectional shape of the bubble generating chamber on the liquid discharge energy generating element is a convex shape.

12. (New) The method for manufacturing a minute structure according to claim 2, wherein the first positive type photosensitive material layer is obtained by forming a first positive type photosensitive material layer by a solvent coating method, vaporizing the coating solvent in the layer by heating, coating a material for forming the second positive type photosensitive material layer, and vaporizing the coating solvent by applying the heat to the formed coating layer.

13. (New) The method for manufacturing a liquid discharge head according to claim 5, wherein the first positive type photosensitive material layer is obtained by forming a first positive type photosensitive material layer by a solvent coating method, vaporizing the coating solvent in the layer by heating, coating a material for forming the second positive type photosensitive material layer, and vaporizing the coating solvent by applying the heat to the formed coating layer.

14. (New) The method for manufacturing a liquid discharge head according to claim 6, wherein the first positive type photosensitive material layer is obtained by forming a first positive type photosensitive material layer by a solvent coating method, vaporizing the coating solvent in the layer by heating, coating a material for forming the second positive type photosensitive material layer, and vaporizing the coating solvent by applying the heat to the formed coating layer.

15. (New) The method for manufacturing a liquid discharge head according to claim 7, wherein the first positive type photosensitive material layer is obtained by forming a first positive type photosensitive material layer by a solvent coating method, vaporizing the coating solvent in the layer by heating, coating a material for forming the second positive type photosensitive material layer, and vaporizing the coating solvent by applying the heat to the formed coating layer.

16. (New) The method for manufacturing a liquid discharge head according to claim 5, wherein the first wavelength range for sensitizing the first positive type photosensitive material layer is a 270 nm to 350 nm range, and the second wavelength range for sensitizing the second positive type photosensitive material layer is a 230 nm to 260 nm range.

17. (New) The method for manufacturing a liquid discharge head according to claim 6, wherein the first wavelength range for sensitizing the first positive

type photosensitive material layer is a 270 nm to 350 nm range, and the second wavelength range for sensitizing the second positive type photosensitive material layer is a 230 nm to 260 nm range.

18. (New) The method for manufacturing a liquid discharge head according to claim 7, wherein the first wavelength range for sensitizing the first positive type photosensitive material layer is a 270 nm to 350 nm range, and the second wavelength range for sensitizing the second positive type photosensitive material layer is a 230 nm to 260 nm range.

19. (New) A liquid discharge head manufactured by the method for manufacturing a liquid discharge head according to claim 5, wherein the height of the liquid flow path is provided relatively lower at a point adjacent to the bubble generating chamber on the liquid discharge energy generating element.

20. (New) The liquid discharge head according to claim 19, wherein the cross-sectional shape of the bubble generating chamber on the liquid discharge energy generating element is a convex shape.

21. (New) A liquid discharge head manufactured by the method for manufacturing a liquid discharge head according to claim 6, wherein the height of the

liquid flow path is provided relatively lower at a point adjacent to the bubble generating chamber on the liquid discharge energy generating element.

22. (New) The liquid discharge head according to claim 21, wherein the cross-sectional shape of the bubble generating chamber on the liquid discharge energy generating element is a convex shape.

23. (New) A liquid discharge head manufactured by the method for manufacturing a liquid discharge head according to claim 7, wherein the height of the liquid flow path is provided relatively lower at a point adjacent to the bubble generating chamber on the liquid discharge energy generating element.

24. (New) The liquid discharge head according to claim 23, wherein the cross-sectional shape of the bubble generating chamber on the liquid discharge energy generating element is a convex shape.